Epidemiologic Studies of Effects of Water Pollution on U.S. Populations

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Health effects of chemical drinking water contaminants

Chemical	Cancer	Developmental/ Reproductive	Neurologic	Other
Aluminum			Alzheimer	
DBPs	Bladder, Colon, Leukemia	SAB, LBW, Defects		
Fluoride	Osteosarcoma			Fluorosis
Lead	Internal		Intelligence	Hemoprotein, Kidneys
Nitrate	Internal	SAB		
Pesticides	Leukemia	LBW		
Radon	Lung			
Sulfate				Diarrhea

Health effects of microbial water contaminants

Health Effect	Drinking Water	Recreational Water
Gastrointestinal Disease	X	X
Respiratory Disease	X	X
Skin Disease	“hospital”	X
Eye, Ear	X	X

Examples of populations susceptible to effects associated with exposure to water contaminants

Contaminant	Susceptible Population
Aluminum	Dialysis patients
Arsenic	Genetic, Nutritional
DBPs	Elderly men, pregnant women
Fluoride	Infants
Lead	Fetus, Children
Microbes	Elderly, Children, Immune Suppressed
Nitrate	Pregnant women, infants
Pesticides	“Children”, pregnant women
Radon	Smokers
Sulfate	Infants

WATER CONTAMINANTS

Arsenic

Disinfection By-Products

Microbes

ARSENIC HEALTH EFFECTS

Cancer

Cardiovascular

Skin

Neurological

INTERNAL CANCERS

Population	Exposure	Cancer	Measure
Fowler's solution	<500 - >2000mg	Bladder	3.07* (SMR)
		Liver	1.23
Cordoba, Argentina	40-533 μg/l	Bladder (M)	2.14*(SMR)
		Bladder (F)	1.82*
Taiwan	0.1-2.0 mg/l-yr	All	1.76* (RR)
		Lung	4.01*
		Bladder	3.58*
Region II, Chile	43-568 μg/l	Bladder (M)	6.0* (SMR)
		Bladder (F)	8.2*
		Lung (M)	3.8*
		Lung (F)	3.1*
		Kidney (M)	1.6*
		Kidney (F)	2.7*
U.S. 30 Counties	> 20 μg/l	Lung (M)	0.8 (SMR)
		Lung (F)	1.1

DERMATOLOGIC

Population	Exposure	Condition	Measure
Fowler's Solution	<500->2000mg	Skin Cancer	2.44 (SMR)
Taiwan (1985)	0- 1.14 mg/l	Skin Cancer	534 (SMR)
Taiwan (1995)	0-25 mg/l-yr	Skin Cancer	13.75* (OR)
Region II, Argentina	43-568 μg/l	Skin Cancer (M)	7.7* (SMR)
		Skin Cancer (F)	3.2*(SMR)
Mexico	0.5-3.9 mg/l	Hyperkeratosis	14.5% (PD)
Mexico	0.41 mg/l	Hyperkeratosis	36* (RR)
India	0.05-3.7 mg/	Hyperpigmentation	20-80% (PV)
China	0.05-1.8 mg/l	Hyperkeratosis	45% (PV)
Utah	0.02-0.8 mg/l	Hyperkeratosis	0%

NEUROLOGICAL

Population	Exposure (mg/l)	Condition
China	0.05	amnesia,peripheral neuropathy
China	0.05-1.8	central & peripheral neuropathy
India	0.05-3.7	peripheral neuropathy
US	0.01	nothing
US	0.01	nothing
US	0.01	nothing

CARDIOVASCULAR

Population	Exposure	Condition	Measure
Fowler's Solution	<500->2000mg	CVD	0.91 (SMR)
		Ischemic Disease	0.85
		Cerebrovascular	0.72
Taiwan (1995)	0-25 mg/l-yr	Ischemic Disease	4.90* (RR)
Taiwan (1997)	0.1-300 μg/l	Cerebrovascular	3.6* (OR)
US, 30 counties	> 20 μg/l	Arteriosclerosis (M)	2.1* (SMR)
		Arteriosclerosis (F)	2.3*
		Dis. Arteries (M)	1.6*
		Dis. Arteries (F)	1.9*

DISINFECTION BY PRODUCTS HEALTH EFFECTS

Cancer

Reproductive

Developmental

REPORTED CANCERS AND DBPS

Bladder

Colon

Rectal

Breast

Lung

Melanoma

All Cancers

Reproductive Outcomes Assessed

Birth Weight	NJ, NS
Low Birth Weight (2500gm)	IA, NJ, NC, CO, NS
Preterm delivery (37 weeks)	IA, NJ, NC, CO,NS
IUGR (SGA)	IA, NJ,NS
Miscarriage (SAB)	NC, CA_2
Stillbirth	NJ, NS
Birth Defects	CA, NJ, NJ_2, NS

Developmental (Birth Defects) Assessed

All Defects	NJ
Neural Tube Defects	NJ, NJ_2, NS
Cardiac Defects	CA, NJ, NS
Oral Cleft Defects	NJ, NS
Chromosomal Defects	NS

MICROBIAL HEALTH EFFECTS

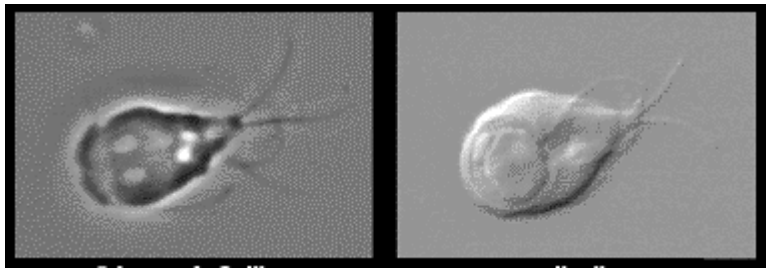
Gastrointestinal Disease

Respiratory Disease

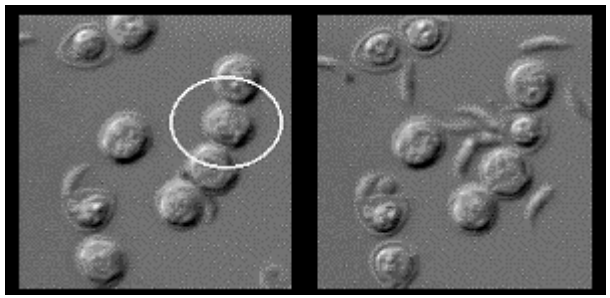
Skin Disease

Eye, Ear Disease

WATERBORNE MICROBES



Giardia

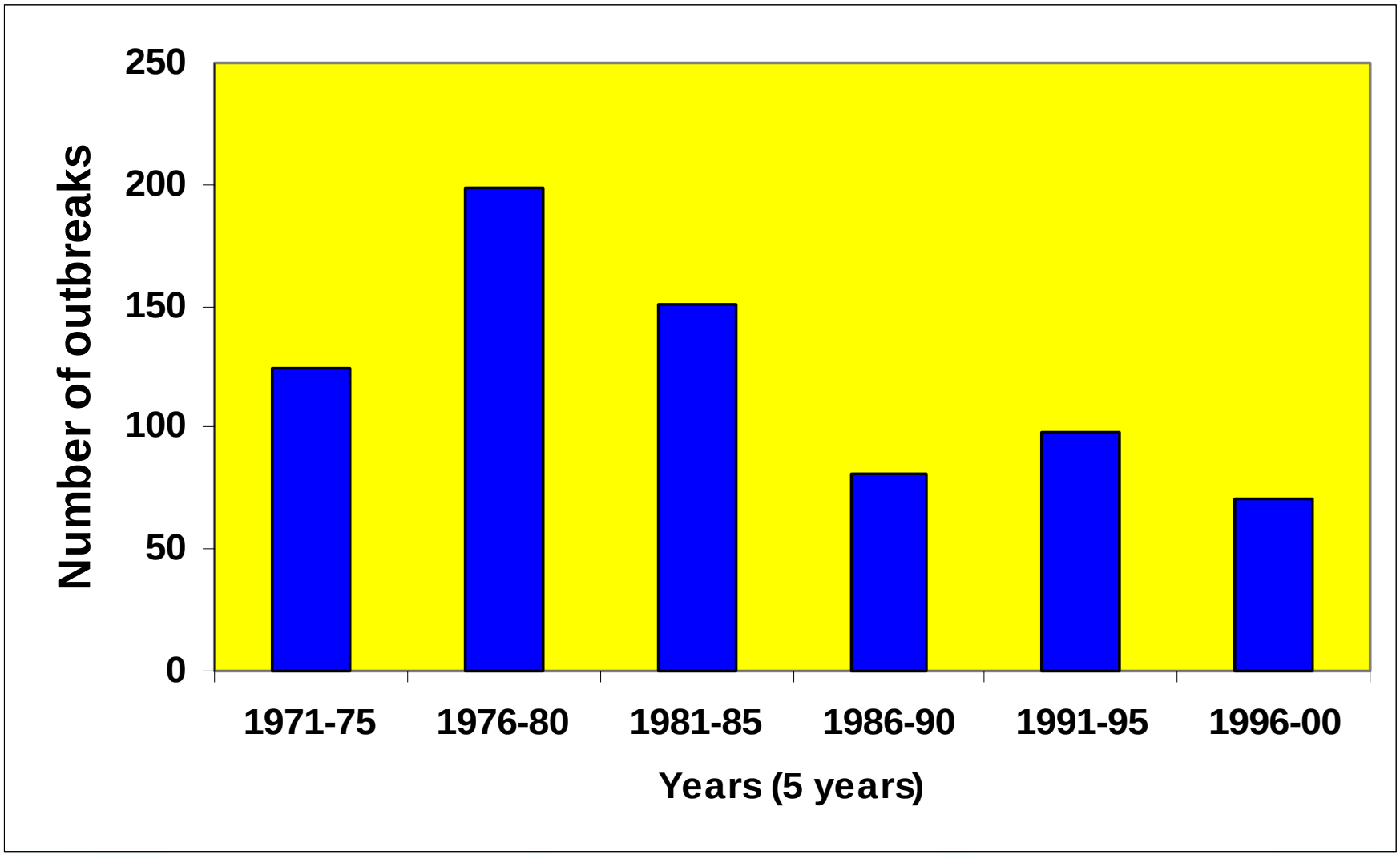


Cryptosporidium

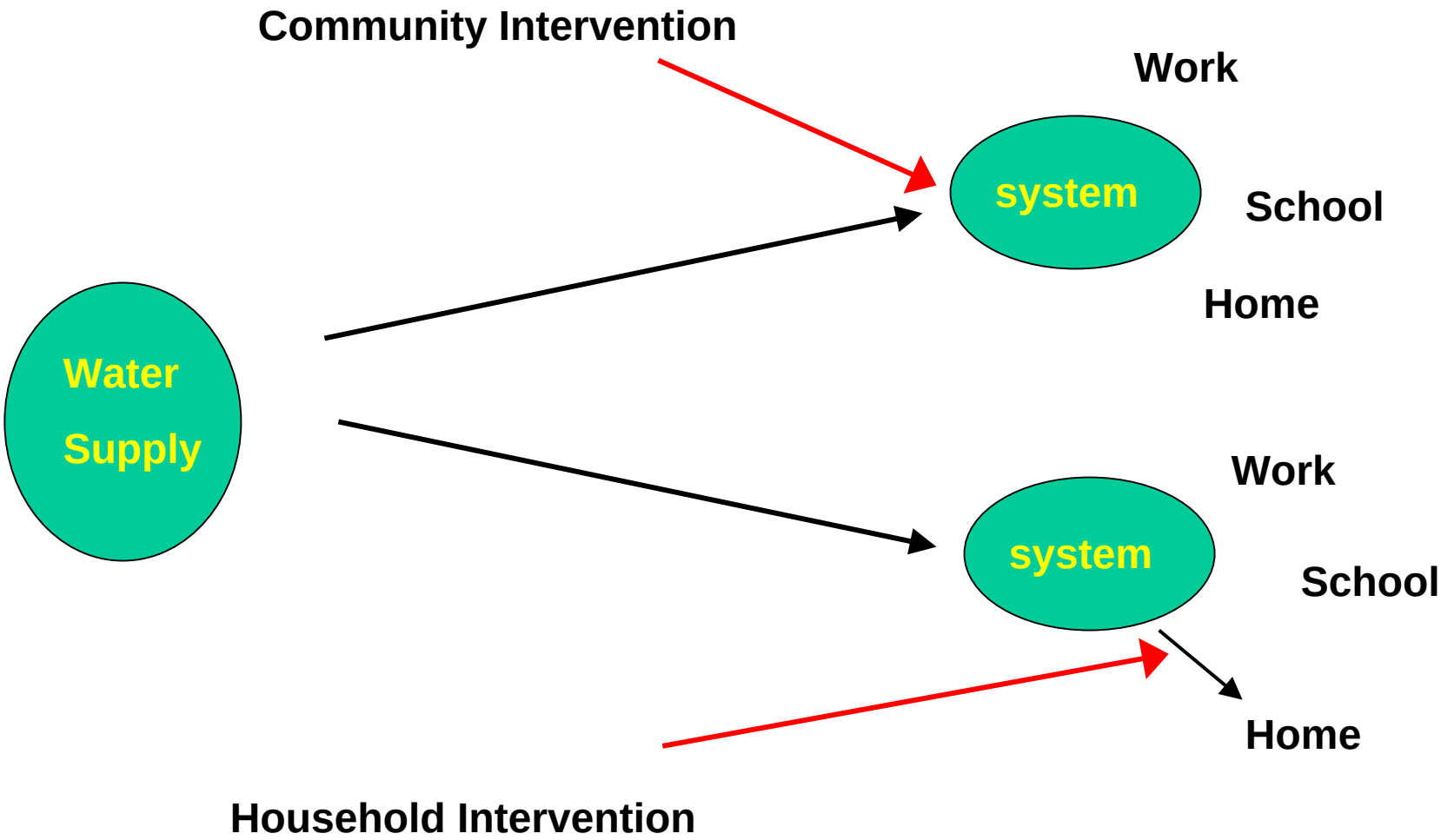
Burden of Gastrointestinal Illness in the United States

- CDC estimates 211 million episodes of acute gastrointestinal (GI) illness occur each year in the US resulting in over 900,000 hospitalizations and 6000 deaths (Mead 1999)
- Many of these cases may be of infectious origin due to food, waterborne or person to person transmission
- Studies by Payment and colleagues in Canada found that 1/3 of GI illness cases are related to drinking water suggesting that up to 70 million cases of GI illness may be caused by waterborne pathogens (Payment 1991& 1997)
- The cost of infectious gastroenteritis in the US, including medical costs and lost productivity, are estimated to exceed $20 billion annually (Peterson 2003)

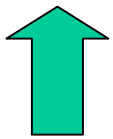
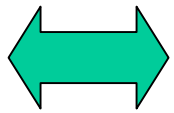
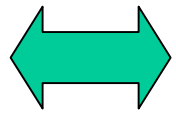
DRINKING WATER OUTBREAKS IN THE U.S. 1971-2000



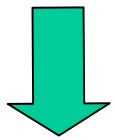
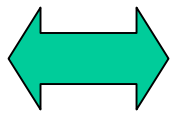
INTERVENTION STUDIES



Endemic GI Illness in DW Household intervention studies

	Payment, 1991	Payment, 1997	Hellard 2001	Colford, 2002
Source Water	Challenged	Challenged	Pristine	Challenged
Blinded	No	No	Yes	Yes
Design	Parallel	Parallel	Parallel	Parallel
Risk in tapwater group				

Endemic GI Illness in DW - Community Intervention Studies

	Northeast	Northwest	Southwest
Source water	Unfiltered surface	Unfiltered surface	Groundwater under influence
Change	Ozone, filtration, chlorine	Ozone, filtration, chlorine	Chlorination, membrane filtration, Cl2
Illness rates after filtration			
Other studies	**Serology, Hospital admissions, Clinical reports**	**Serology, school absentism**	**Serology, school absentism**

Microbial Illnesses and Drinking and Recreational Water

Illness	Drinking Water	Recreational Water
Gastrointestinal	Enteric Organisms	Enteric Organisms
Respiratory	Legionella, Viruses, OPs	Viruses, Algal Toxins
Skin	Pseudomonas, OPs	Schistosomes, Legionella, Pseudomonas
Eye, Ear	Bacteria, Viruses	Bacteria, Viruses

OVERVIEW

- BEACHES Act of 2000 from Congress
  - 1. Develop microbial indicators for beach water quality
  - 2. Develop efficient protocols for monitoring
  - 3. Assess human health risks
  - 4. Provide guidance to beach managers

- Final Goal: New risk-based water quality guidelines & rapid monitoring methods for recreational waters.

STUDY APPROACH

Water sampling methods

New rapid detection methods

Health studies

New, rapid, validated water quality indicators (under 2 hours for results)

Contact Information

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